IN THE UNITED STATES PATENT OFFICE

Kjell-Tore Smith, et al
Serial No. 10/717461
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Title: Pressable plastic-bound explosive composition
Examiner: Gellner Group no. 3643
Atty docket no. 115700

DECLARATION UNDER 37 CFR §1.132

I, Gunnar Nevstad, hereby DECLARE as follows:

In relation to the invention in US 10/717, 461, I have been asked to comment the case. I am familiar with the application, the last office action from the examiner, and the references to Newman and Rothstein. I am a MSc in chemistry from the university of Bergen, Norway and I have been working as scientist and as principal scientist since 1985 at the Norwegian Defence Research Establishments. My area of expertise through all these years has been related to energetic materials i.e. high explosive formulations as well as gun and rocket propellants. I am in no way related to the applicant and have an independent position. The following statements are made of my own knowledge and belief. I understand fully that the making of wilful false statements in a Declaration is a criminal offence.

Basically it is important to understand the lines between PBX and propellants. Further it is important to understand the differences between various PBX groups of materials and why we distinguish these groups of materials from each other. The processing technology applied for pressable PBX compositions (including the current invention) is completely different from the processing technology of cast/cure PBX, melt/cast PBX and castable propellants.

Pressable PBX materials are to be pressed or compacted into various warheads. The explosive granules are filled into a tool and compacted by applying pressure. This is considered to be a relatively dangerous operation depending on the pressure applied. Industrially the typical force range is 1500-2000 kg/cm^2. There are a number of pressable formulations available and in use in the ammunition business such as PBXN-3, PBXN-5, LX-14, PBXN-9 etc. When applied as main charge the producer would like to achieve the highest density possible without risking an accident. High density means high performance and a less shock sensitive charge, which is of

increasing importance today in order to produce so called Insensitive Munitions (IM) compliant munitions. The resultant density is typically expressed as % of Theoretical Maximum Density. In order to maximize the density of the finished charge a number of various parameters are optimized such as heat, vacuum, pressing force, pressing cycles and pressing tool (single-end, double-end, isostatic). Obviously the characteristics of the granules themselves are influencing the result as well, i.e. granule size and size distribution, type and quantity of binder material, quality of crystal coating and the crystal size distribution of the applied crystals in the granules. During pressing all the above-mentioned parameters are interacting. It is difficult to rank the importance of the various parameters in order to achieve the highest density. For instance, during pressing the crystal size distributions will change as a result of the force applied (crushing). For a person skilled in the art all the above mentioned parameters are well known and in the literature you will find details described on each and every single parameter. In general it is hard to achieve %TMD values above 96-97% without using sophisticated pressing procedures and optimized products. Industrially values above 98% of TMD are hardly seen in charges. The minimum % TMD requirements in military specification requirements for pressable PBX materials are:

	Milspec requirement	% binder	Typical values achieved (%TMD)
PBXN-3	>98%	14	98,3
PBXN-5	> 96,5%	5	97,7
LX-14	-	4,5	97,2
PBXN-9	Min1,72 g/cm3 = 97,2% TMD	8	97,7
PBXW-11	Min 1,77 g/cm3 = 96,3% TMD	4	96,3

Newman et al are describing a very interesting explosive composition, PBXW-17, in their article. They are stating that %TMD values as high as 98,5% is achievable. As can be seen in the pressing curve in Newman et al it is hard to get above 98,5 % even if higher-pressure force is applied i.e. > 2000 kg/cm^2. Because of the rubbery consistence of the binder Newman is stating

that to achieve 98,5 - 99% of TMD is extremely difficult which any person skilled in the art would not disagree with.

Based on the above-mentioned explanations the current invention is remarkable. There are examples where % TMD values above 99 are achieved with pressing forces below 500 kg/cm^2 and with higher but still moderate pressures values at 100 can be achieved! This is indeed nothing one would expect. Increased performance and less sensitive charges are very attractive properties in the ammunition market. In addition the producer of munitions will see benefits relating to safety (lower pressure needed) and improved processability and potentially lower production costs.

The examiner is referring to work related to a different group of PBX materials i.e. Rothstein and his work on cast/cure type of PBX materials. Regarding cast/cure explosive composition as well as melt/cast explosive compositions they are processed in a completely different way than pressable PBX materials. In cast/cure and melt/cast explosive compositions the material is poured or cast not pressed into charges and the parameters controlling the result is obviously different.

Rothstein, teaches the use of multimodal particle size distributions in cast-cured plastic bonded explosives. In this case the explosive crystals (RDX or HMX) are mixed with a cast-curable prepolymer (normally Hydroxy-Terminated PolyButadiene, HTPB) with an isocyanate as curing agent and a cure-catalyst. The production process is to mix the explosive crystals with the HTPB and the other ingredients, pour the explosive mix into the warheads and cure the composition at elevated temperatures for 4-6 days. The main problem with this group of explosive formulations is to be able to mix as much solid material (explosive crystals) as possible with as little prepolymer as possible, and at the same time get a castable, flowable composition that can be poured into the warheads without any entrapped air. Unlike pressable PBX the particles are not forced and crushed into a warhead. In Rothstein the motivation is to achieve a pourable mixture that gives a low viscosity.

The literature describing how to achieve maximum packing density is rich and goes back more than 40 years. The most basic and introductory lesson would be *R.J. Farris: Prediction of the viscosity of multimodal suspensions from unimodal viscosity data, Trans. of the Society of Rheology, 12:2, 1968*). In spite of 40 years of development particle sizes and size distributions are still investigated and discussed, yet without showing the results of the current invention. For

a person skilled in the art it is well known that experience made with one explosive composition cannot be transferred automatically to another explosive composition and especially not between different groups of explosives such as pressable and cast/cure and even not between cast/cure and melt/cast explosive compositions. The teachings of Rothstein et al as well as a number of other similar articles do not represent any obvious motivation for a formulator of pressable explosive compositions.

It is also well known to anyone skilled in the art that particle sizes and surface areas are used to control the burning rate of propellants. Also, modern rocket propellants have strong similarities with cast-cured explosives in that the same type of binder systems is used, together with the same processing and casting technology. However, burning rate is irrelevant for explosives, whether it is cast-cured or pressed. Explosives detonate, and a detonation is completely different from burning both in terms of the physical/chemical process, and the reaction rate. The reaction rate is several orders of magnitude faster for a detonation compared to burning, and the detonation velocity is independent of the explosive particles size.

Based on the above-mentioned explanations the current invention is remarkable. There are examples where % TMD values above 99 are achieved with pressing forces below 500 kg/cm^2 and with higher but still moderate pressures values at 100 can be achieved! This is indeed nothing one would expect. Increased performance and less sensitive charges are very attractive properties in the ammunition market. In addition the producer of munitions will see benefits relating to safety (lower pressure needed) and improved processability and potentially lower production costs.

The examiners arguments are based on simple assumptions that experience from one area of processing technology can be transferred to another area of processing technology. This is a view which represents an underestimation of the development efforts in explosive community and the current invention.

Gunnar Nevstad date: 31/10 - 07

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